
By Paul Tipton BDS MSc DGDP(UK)

INTRODUCTION
The success of aesthetics and restorative dentistry depends upon the clinician's understanding of natural tooth form. Recent advances in adhesive dentistry, dental materials and dental technology have increased the ability of the clinician to mimic the natural dentition. In patients who are dissatisfied with the appearance of crowded teeth, orthodontics is the ideal treatment. However, in some of these cases patients are not prepared to go forward with this treatment due to time constraints and quicker restorative modalities are requested that require a combination of smile analysis, diagnostic procedures, gingival contouring and tooth preparation techniques, but always visualising the end result for success.

SMILE DESIGN
Technical advances in dental ceramics throughout the last 15 years have allowed ceramists to fabricate restorations that approach the aesthetics of the natural dentition (Kern, Mishimura & Campbell, 1996). However, achieving this aesthetic improvement in the mouth also needs the clinician to visualise the end result that is the beauty of the natural dentition (Winter, 1993). In order to visualise the end result the diagnostic wax up, provisional restoration and tooth preparation guide (Shavell, 1994) are essential components. The principle elements in achieving a pleasing and aesthetic smile is based on 'smile design' (Morley & Eubank, 2001). This involves creating an incisal plane parallel to the eyes (Roach, 1988) and curving upwards to mimic the lower lip during smiling (Chiche & Pinault, 1994). The starting point of the aesthetic treatment plan is often the mid-line (Spear, 1999) although subtle changes are permissible as one moves further laterally away from the centreline. All of these aspects have been covered in Part 1 of this series.

ANTERIOR CROWDING
Although greater numbers of adults are undergoing orthodontic procedures for aesthetic correction of anterior crowding than in previous years, a significant proportion of this patient population remains opposed to such treatment. An orthodontic solution, although ideal, may nonetheless be rejected by the patient even though ceramic brackets, as well as lingual orthodontic appliances have minimised the unaesthetic appearance of the modality. Numerous patients continue to select restorative treatment as a quicker alternative to time-consuming orthodontics.

If non-orthodontic realignment is requested, the patient should be informed of the potential limitations and must understand that the definitive results may be a compromise being less than ideal from an aesthetic and functional standpoint. If an optimal smile can be achieved by orthodontic means, the patient should be strongly advised that this is the treatment of choice. The following case studies illustrate patients who were dissatisfied with the appearance of their crowded teeth and had refused orthodontic treatment several times before being referred for a specialist restorative solution. The same smile design principles and treatment planning procedures are adapted for all these cases to ensure a final predictable aesthetic end result.
Numerous studies have shown the excellent success rates for porcelain veneers (Calamia, 1989; Calamia, 1993; Garber, 1993). Based on these results, the range of indications has increased to include fractured teeth (Andreasen et al, 1991), worn down anterior dentitions (Walls, 1995a & 1995b), diastema closure (Tipton, 2001) and treatment of crowding (Shannon, 1999). Preparations for veneers should usually cross the incisal edge for strength and control stress distribution (Highton et al, 1987) and finish with a mini chamfer on the palatal surface after a 1.5mm reduction of the incisal edge (Belser et al, 1997). This extension onto the palatal surface creates composite bonds at right angles to the direction of displacement of the veneer during the initial phases of protrusive movements along the palatal-incisal area of the tooth (Garber, 1993). Interproximal preparations have involved preparations up to and half way into the contact areas (Belser et al, 1997) for minimal preparation techniques. However, when major changes in form are required as in the case of crowded teeth wrapping around both incisally and interdentally is recommended (Belser et al, 1997; Rouse, 1997). The interproximal margins are extended in a palatal direction beyond the interproximal contact points allowing the ceramist maximum opportunity to create correct aesthetic form and function.

CASE STUDY 1
This young lady (Figure 1) was referred to St Ann’s Dental Clinic by her general dental practitioner in St Helens. She was unhappy about the appearance of her smile (Figure 2) due to the crowding of her maxillary anterior teeth (Figure 3). Orthodontics was offered but refused by that patient due to the time required to complete treatment. The initial diagnostic phase included mounted study casts and diagnostic waxing (Figure 4) to envisage the final end result. Periodontal surgery by way of crown lengthening to even the gingival margin alignment was also refused, again due to a time basis. Upon verification of the final shape, length and appearance of the wax-up, prototype restorations (Figure 5) and preparation guides (Figure 6) were prepared ready for the preparation stage.

Veneer preparations were...
performed on the upper right central lateral and canine teeth and the upper left central incisor using the preparation guide (Figures 7 to 9). Upon formalising the preparations and prior to the impressions, the remaining dentine was sealed with one-step bonding system (Optident). Impressions were taken after light pumicing of the teeth to remove the surface oxygen inhibition layer of composite which could interfere with set of the impression material (Provil and Monophase – Heraeus Kulzer). Acrylic prototype restorations shaped to the final shape and form were cemented with ‘Temp Bond Clear’ (Kerr).

A full ceramic porcelain restorations etched restorations, fabricated by the dental technician and etched on the fit surface with hydrofluoric acid, were tried in prior to cleaning with phosphoric acid to remove all debris and saliva and silaning with ‘Silicoup’ (Heraeus Kulzer) to increase the bond strength of composite to the etched porcelain fit surface. The veneers were then cemented with one-step bonding system (Optident) and Nexus 2 composite luting cement (Kerr) using rubber dam and isolating from the left canine to the right second premolar.

The final aesthetic result (Figures 10 to 13) shows harmony between the veneers and the contra-lateral natural teeth.
CASE STUDY 2

This young girl was referred to St Ann's Dental Clinic by her general dental practitioner in Liverpool after refusing to undergo orthodontic treatment to correct her severe maxillary anterior crowding (Figures 14 to 17). Standard diagnostic procedures were undertaken prior to starting treatment, including mounted study casts, diagnostic wax-up (Figure 18), tooth preparation guides (Figures 19 & 20) and prototype restorations. The goal of treatment was to correct anterior crowding by means of etched porcelain restorations and soft tissue gingival reshaping.

TOOTH PREPARATION

It is advisable that the dentist first makes the anticipated diagnostic preparations on study casts, to ensure that all aspects of preparation design be realistic and accurate. Teeth that are rotated labially must be prepared so that the labial height of contour of the preparation is in arch-form alignment with the adjacent preparations. It is equally critical to open up the interproximal aspect of the preparation on the surface that is labially placed. This allows adequate clearance for porcelain application to create the illusion of proper alignment as viewed from the front. The goal of tooth preparation in these cases is to 'orthodontically' align all the preparations making it easier for the technician to achieve the ultimate aesthetic result. Tooth preparation started with conventional veneer preparations using supragingival margins to the labial surfaces of the two central incisors as the position of these two teeth were deemed ideal. Incisal reduction was 1.5mm with heavier tooth preparation on the distal aspect in the form of slice preparation so as to open up this area to allow the lateral incisors to come forward. Tooth preparation for both lateral incisors included heavy 2mm palatal preparation, and minimal labial reduction apart from a 0.5mm gingival finishing line. Both canines, which were initially outstanding from the arch, were prepared with a 2.2mm labial reduction (Shillingburg & Grace, 1973) so as to avoid exposure. In this way,
by the attachment of 0.5mm etched porcelain restorations, the canines could be moved more palatally and the lateral incisors moved more buccally into perfect alignment. In order to move the upper left lateral incisor forwards, as well as heavy preparation on the distal aspect of the left central incisor, the mesial aspect of the upper left canine was also heavily prepared so as to allow this forward movement of the lateral incisor (Figures 21 to 23). Provisional restorations made from the diagnostic wax-up in composite were then relined using ‘Prevision’ (Heraeus Kulzer) and cured directly onto the tooth preparations with no intervening dentine bond after the dentine had been sealed by the use of Gluma desensitiser. The shrinkage of the ‘Prevision’ composite is adequate to hold the provisional restorations in place on the prepared teeth for up to 10 days whilst the definitive restorations are made. To avoid blackening of the prototype veneers, the patient is instructed to avoid alcohol and use carbamide peroxide around the gum margin by rubbing with a cotton bud.

**SOFT TISSUE RESHAPING**

The palatal displacement of the lateral incisors meant that the soft tissues over the gingival margins of these teeth were at a lower level than the adjacent central incisors and canines. The bone was sounded by periodontal probing in the sulcus to establish whether gingivectomy (soft tissue removal) or periodontal flap surgery and bone contouring was appropriate. There was excess soft tissue present and therefore gingivectomies were performed on the labial aspects of the upper lateral incisors to bring their gingival margins into a more perfect alignment with the centrals and canines.

**TECHNICAL PROCEDURES**

Technical procedures followed which included production of a Geller model (Willer Geller) with removable stone dyes in a acrylic model (Figures 24 & 25). This allowed guided soft tissue sculpturing of the interdental papillae by preparation of the acrylic model so as to eradicate any black triangles in the final
restorations (Bichacho, 1996) (Figures 26 to 29). Contact areas between these restorations were carefully planned so that the coronal aspects of the contact area was no greater than 5mm from the interdental bone. This was accomplished by probing the interdental bone between preparations and measuring the distance from the incisal edge of the adjacent preparation to the interdental crest of bone. This was then in a position to form his contact areas 5mm incisal to the interdental crest of bone. The technician was then in a position to form his contact areas 5mm incisal to the interdental bone crest to eliminate any potential black triangles (Tarnow et al, 1992). In order to recreate the same emergence profile for both lateral incisors the neck of the upper left lateral incisor was deliberately over-contoured so that the necks of both lateral incisors were now in the same horizontal plane (Figure 30) making for a more pleasing appearance as the soft tissue settled into the area.

The all-ceramic restorations were made of vita porcelain and were bonded onto the teeth using several coats of ‘One Step’ dentine bonding system (Optident) and Nexus 2 light curing composite luting cement (Kerr) and after acid etching the remaining enamel for 30 seconds and dentine for 15 seconds, drying to assess the enamel etch pattern and rehydrating with ‘Tublicid’ antimicrobial wetting agent impregnated with fluoride (Fielding Dental). Immediately after fitting of the restorations, however, there appeared a loss of interdental papillae on the upper left side between the central and lateral incisors.
cleansible, allowing good periodontal health and maintenance (Figures 35 & 36). Three months later after review, a full interdental papilla can be seen once the soft tissue has matured.

**CONCLUSIONS**

The final end result fulfills all the requirements of an aesthetic restoration in that it is pleasing in appearance, easily cleanable, allowing good periodontal health and maintenance (Figures 35 & 36). The aesthetic correction in such areas where orthodontics is not performed relies on a combination of tooth preparation techniques, knowledge of tooth anatomy and dentine adhesion, excellent technical support and determination of bone levels in conjunction with correct contact area placement.

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REFERENCES


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Q1 What criteria are used to design a smile?
   a) Incisors parallel to lower lip
   b) Incisors parallel to the ground
   c) Incisors parallel to eyes

Q2 What is the ideal tooth preparation for veneers?
   a) 0.5mm
   b) Stay in enamel
   c) Design the preparation for the final end result

Q3 How should you treat dentine after tooth preparation?
   a) Clean with pumice
   b) Wash with water
   c) Etch and dentine bond
   d) All of the above

Q4 How much dentine and enamel is there in the mid buccal area of an average adult dental tooth?
   a) Less than 2mm
   b) More than 2mm
   c) Exactly 2mm

Q5 What is the Geller model made of?
   a) Plaster
   b) Acrylic
   c) Silver